Electronic structure and decoherence of the VB center in hexagonal boron nitride for sensing in low dimensions

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Point defects quantum bits in wide-bandgap semiconductors with controllable electron and nuclear spin states provide a versatile toolbox for developing applications in the fields of quantum sensing, quantum information processing, and quantum computation. Recently, two-dimensional semiconductors have gained considerable attention for hosting quantum states. The negatively charged boron vacancy center (VB center) [1] is among the first point defect qubits in hexagonal boron nitride (hBN), whose spin could be initialized, coherently manipulated, and read out.[2] The possibility of exfoliation of hBN and the creation of vacancy centers close to the surface have opened new horizons for quantum sensing low dimensions.[3]
My talk outlines the physics of the VB center in hBN, see Fig. 1, and discusses recent advances in light of quantum sensing. In particular, I will discuss the electronic structure and optical spin polarization mechanism of the VB center and identify key ingredients of the quantum noise of hBN quantum sensors.[1,4,5] I will show that by shifting from low magnetic fields to higher magnetic fields, the decoherence mechanisms of the VB center involve different flavors of hyperfine coupling and many-body physics. I will discuss optimal magnetic field ranges and possible coherence-protecting strategies. These findings collectively advance our understanding of the VB center in hBN and its potential applications in quantum technologies.

References

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Figures

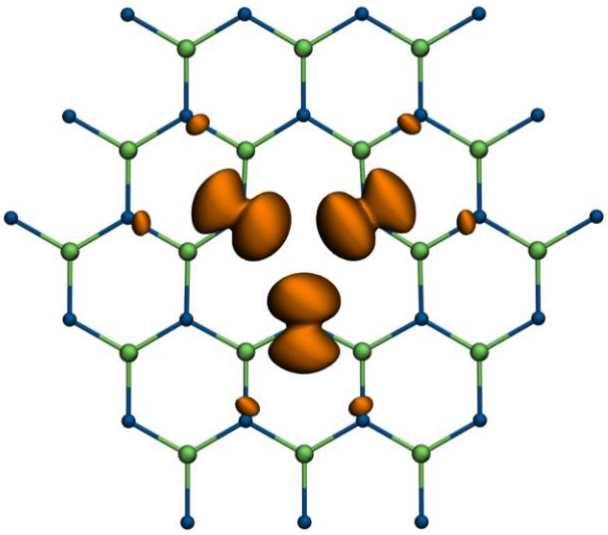

Figure 1: Structure and spin density of the negatively charged boron vacancy center in hexagonal boron nitride.